

# **Chinook Salmon Stocking Technique Study**

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## **ABSTRACT**

During the spring of 1998 and 1999, experimental lots of chinook salmon fingerlings, marked with coded wire tags (CWT), were stocked in the Kewaunee River at various distances upstream from Lake Michigan (harbor, four miles, nine miles, and 15 miles) to determine if stocking location had an impact on mature salmon recovery rates.

Over 5,000 mature CWT chinook salmon from this study were collected at Besadny Anadromous Fisheries Facility (BAFF), fall 1999 through fall 2002. Few additional recoveries of chinook from this study are anticipated. Chinook fingerlings from both year classes that were stocked at the intermediate distances (four miles and nine miles) had higher recovery rates as mature fish at BAFF than fingerlings stocked in the harbor or 15 miles upstream. Harbor stocked fish were recovered at higher rates by anglers and as strays to Strawberry Creek Weir. The 1999 year class was recovered at nearly five times the rate of the 1998 year class.

Stocking location did not appear to affect subsequent size at age. The 1998 year class was larger (length and weight) at age than the 1999 year class.

## **INTRODUCTION**

The Wisconsin Department of Natural Resources (WDNR) has been stocking chinook salmon as part of the Lake Michigan anadromous fisheries management program since 1969. Over the last two decades, the WDNR has completed several coded wire tag (CWT) studies that have helped us improve the efficiency of chinook fingerling rearing and stocking. The studies have included evaluations of hatching, rearing, sterilization, and stocking techniques.

One of the previous studies (Peeters and Toney, 1995) compared recovery rates of chinook fingerlings stocked by three different techniques. This study demonstrated that chinook fingerlings stocked in a river or in a rearing pond with subsequent release to a river are recovered at higher rates than chinook fingerlings stocked directly into Lake Michigan. In the chinook fingerling stocking technique study, rearing pond fingerlings were recovered at a rate of 0.356 as compared to a rate of 0.303 for river stocked fingerlings, and a rate of 0.149 for lake stocked fingerlings. Harbor stocked fingerlings became an unplanned, nonreplicated part of this study when fisheries technicians decided, that because of a pounding Lake Michigan surf on the day of stocking, to put one of the chinook lots destined for the lake, in the harbor. This group of harbor stocked fingerlings was subsequently recovered at a higher rate (0.460 percent) than fingerlings stocked by any of the other techniques.

Researchers on the Pacific Coast (Tabor et al. 1993) demonstrated that in spring and early summer, in the Columbia River, Washington, juvenile salmonids (mostly subyearling chinook

salmon) were 59 percent of smallmouth bass diets and 28.8 percent of northern squawfish diets. If in fact the rivers in which chinook fingerlings are stocked become a predator lined gauntlet that they must run, stocking further upstream may increase the risk of predator encounter. The stocking of chinook fingerlings in a river has been shown to be more effective than stocking directly into the lake, however, stocking of chinook too far upstream may be counterproductive. This study will attempt to further refine chinook fingerling stocking techniques by stocking four lots of CWT chinook fingerlings in the Kewaunee River at various distances upstream from Lake Michigan.

In previous CWT chinook salmon studies conducted by the WDNR, tag recovery from anglers was disappointingly low (Peeters, 1995, and Peeters and Toney, 1995). Despite signs posted at boat landings, radio advertisement spots, newspaper articles, presentations at sport club meetings, creel clerk contacts, and a monetary reward offered for the return of CWTs, large numbers of anglers were unaware of the CWT program, and many of those that were aware were apathetic with regard to their participation. The Kewaunee River was chosen for this study because the Besadny Anadromous Fisheries Facility (BAFF) located on the Kewaunee River, would facilitate collection of mature chinook with CWTs.

## **METHODS**

### **Egg collection/stocking of the 1998 year class**

During the falls of 1997 and 1998, chinook salmon eggs collected from the WDNR Strawberry Creek Weir (SCW) were transported to the WDNR Wild Rose Fish Hatchery for hatching and rearing. During April of 1998 and 1999, study fingerlings were divided into four lots and marked with an adipose fin clip and CWTs (Table 1). Fingerlings for this study were held at the Wild Rose Fish Hatchery in central Wisconsin until stocking. On May 1, 1998, the four lots of CWT chinook fingerlings from the 1998 year class were transported to the Kewaunee River and stocked (Table 1). Each lot was between 25,000 and 26,000 fingerlings and average fingerling weights within the four lots ranged from 4.17g to 4.37g. Average length of the CWT chinook fingerlings was 79.5mm. CWT retention rates as estimated by the hatchery staff at Wild Rose ranged from 96.6 percent to 99.7 percent and averaged 98.5 percent. On May 17, 1999, the four lots of CWT chinook fingerlings from the 1999 year class were transported to the Kewaunee River and stocked (Table 1). Each lot was between 22,000 and 25,000 fingerlings and average fingerling weights within the four lots ranged from 5.47g to 5.90g. Average length of the CWT chinook fingerlings was 87.8mm. CWT retention rates as estimated by the hatchery staff at Wild Rose ranged from 96.8 percent to 100.0 percent and averaged 99.1 percent.

Table 1.-CWT lot number, number, average weight (as estimated by a hatchery weight count), and percent tag retention (as estimated by the hatchery) for each of the lots of chinook fingerlings for the stocking location study.

YEAR CLASS	CWT LOT NUMBER	NUMBER OF FINGERLINGS	AVERAGE WEIGHT	PERCENT TAG RETENTION	STOCKING SITE
<b>1998</b>	31/17/21	25,443	4.32g	99.2	HARBOR
	31/17/22	25,533	4.28g	96.6	BAFF
	31/17/23	25,529	4.17g	98.6	CLYDE'S
	31/17/24	25,586	4.37g	99.7	HWY 54
	AVERAGE		4.28g	98.5	
<b>1999</b>	31/17/31	22,037	5.47g	100	HARBOR
	31/17/32	24,473	5.68g	100	BAFF
	31/17/33	24,515	5.82g	99.4	CLYDE'S
	31/17/30	24,354	5.90g	96.8	HWY 54
	AVERAGE		5.72g	99.1	

In 1998 the four lots of CWT chinook fingerlings were stocked at the preselected stocking locations on the Kewaunee River, in Kewaunee County, Wisconsin. Lot 31/17/21 was stocked in the Kewaunee Harbor near the mouth of the Kewaunee River. Lot 31/17/22 was stocked at the Besadny Anadromous Fisheries Facility (BAFF), approximately four miles upstream from Lake Michigan. Lot 31/17/23 was stocked at the Clydes Hill Road crossing of the Kewaunee River, approximately nine miles upstream from Lake Michigan. Lot 31/17/24 was stocked at the U. S. Highway 54 crossing of the Kewaunee River, approximately 15 miles upstream from Lake Michigan. All four lots were stocked on May 1, 1998 within a two-hour time period. A small sample (50 from each lot) of the CWT chinook fingerlings were sacrificed at the time of stocking as a quality check of estimated length and weight (Table 2), CWT retention, CWT number accuracy, and lot fidelity (Table 3). Two of the 200 chinook fingerlings sampled in 1998 did not have a tag, for an overall tag retention rate of 99 percent, and all 198 of the tagged fingerlings had the correct lot number.

Table 2.-Stocking date, and average length and weight of chinook (as estimated from a 50 fish sampled sacrificed at the time of stocking) for the stocking technique study 1998 and 1999 year classes.

YEAR	STOCKING LOCATION	NUMBER STOCKED	STOCKING DATE	SAMPLE SIZE	AVERAGE LENGTH	AVEARGE WEIGHT
1998	HARBOR	25,443	5/1/98	50	80.4	4.7
	BAFF	25,533	5/1/98	50	79.2	4.2
	CLYDE'S	25,529	5/1/98	50	77.8	4.0
	HWY 54	25,586	5/1/98	50	80.6	4.2
1999	HARBOR	22,037	5/17/99	52	86.4	5.0
	BAFF	24,473	5/17/99	52	89.8	5.8
	CLYDE'S	24,515	5/17/99	50	86.6	5.2
	HWY 54	24,354	5/17/99	50	88.6	5.4

Table 3.-CWT retention (as estimated from a 50 fish sample sacrificed at the time of stocking) for the stocking technique study 1998 and 1999 year classes of chinook.

YEAR	CWT LOT NUMBER	SAMPLE SIZE	NUMBER WITH CORRECT TAG #	NUMBER WITH WRONG TAG #	NUMBER WITH NO TAG	PERCENT CORRECT TAG RETENTION
1998	31/17/21	50	50	0	0	100.0
	31/17/22	50	49	0	1	98.0
	31/17/23	50	49	0	1	98.0
	31/17/24	50	50	0	0	100.0
	TOTAL	200	198	0	2	99.0
1999	31/17/31	52	52	0	0	100.0
	31/17/32	51	50	0	1	98.0
	31/17/33	50	48	1	1	96.0
	31/17/30	48	46	0	2	95.8
	TOTAL	201	196	1	4	97.5

In 1999 the four lots of CWT chinook fingerlings were stocked at the preselected stocking locations on the Kewaunee River, in Kewaunee County, Wisconsin. Lot 31/17/31 was stocked in the Kewaunee Harbor near the mouth of the Kewaunee River. Lot 31/17/32 was stocked at a boat landing just downstream of the BAFF, approximately four miles upstream from Lake Michigan. Lot 31/17/33 was stocked at the Clydes Hill Road crossing of the Kewaunee River, approximately nine miles upstream from Lake Michigan. Lot 31/17/30 was stocked at the U. S. Highway 54 crossing of the Kewaunee River, approximately 15 miles upstream from Lake Michigan. All four lots were stocked on May 17, 1999 within a two-hour time period. A small sample (approximately 50 from each lot) of the CWT chinook fingerlings were sacrificed at the time of stocking as a quality check of estimated length and weight (Table 2), CWT retention, CWT number accuracy, and lot fidelity (Table 3). One of the tagged fingerlings was mixed in

with the wrong lot, and four of the fingerlings sampled did not have a tag, for an overall correct tag retention rate of 97.5 percent.

During fall salmon harvest operations at BAFF from 1999 through 2002, all adipose clipped chinook that were captured alive, were measured to the nearest millimeter and weighed to the nearest .02 kilogram with an electronic digital scale. Sex was visually determined and heads of all adipose-clipped salmon (probable CWT) were marked with a sequentially numbered jaw tag, collected, and frozen for future examination. In the lab, the presence of a microtag in each head was confirmed with the use of a metal detector. All CWTs were retrieved by dissection and decoded with the use of a compound microscope. The binary code on each CWT identifies the agency that stocked the fish, year of stocking, and the location of stocking of each group of fish.

In addition to the recoveries of chinook from this study at BAFF, chinook from this study were also recovered by sport anglers participating in the Lake Michigan fishery and as strays at the WDNR Strawberry Creek spawning weir.

## **RESULTS AND DISCUSSION**

### **Rate of Recovery**

#### **Recoveries at Besadny Anadromous Fisheries Facility**

From the fall of 1999 through fall of 2002, nearly 6,000 chinook salmon with an adipose fin clip were observed at BAFF. CWTs were successfully extracted and decoded from 5,177 chinook (Appendix 1). A total of 4,771 of the chinook were identified as being part of the stocking technique study (Table 4). Chinook fingerlings from the 1998 year class of the stocking technique study had a cumulative recovery rate of 0.86 percent and the 1999 year class had a cumulative recovery rate of 4.08 percent. The difference between the recovery rate for the 1998 and 1999 year classes returning to BAFF is not believed to be related to the stocking location study as similar recovery rates for the 1998 and 1999 year classes were observed for CWT chinook returning to the WDNR Strawberry Creek Weir (SCW). Cumulative recovery rate for the 1998 and 1999 year classes of CWT chinook returning to SCW was 1.50 and 5.00 percent respectively (WDNR management report in preparation).

Table 4.- Rate of return for chinook salmon stocking technique study, at age, to the Besadny Anadromous Fisheries Facility. Rate of return expressed as a percent of the number of chinook stocked in the Kewaunee River that were actually recovered at the Besadny Anadromous Fisheries Facility through the fall of 2002. The percent return is followed by the actual number of fish recovered in parentheses.

Year Class	STOCKING LOCATION	AGE AT RETURN				CUMULATIVE Rate of Return
		1+	2+	3+	4+	
1998	HARBOR	0.14 (35)	0.13 (34)	0.19 (48)		0.46 (117)
	BAFF	0.37 (94)	0.22 (57)	0.33 (85)		0.92 (236)
	CLYDE'S	0.41 (105)	0.31 (78)	0.60 (153)	<0.00 (1)	1.32 (337)
	HWY 54	0.22 (57)	0.22 (56)	0.29 (75)		0.73 (188)
1999	HARBOR	0.32 (70)	1.55 (341)	2.26 (498)		4.12 (909)
	BAFF	0.53 (129)	1.88 (460)	2.40 (587)		4.81 (1,176)
	CLYDE'S	0.53 (129)	1.86 (457)	2.42 (594)		4.81 (1,180)
	HWY 54	0.30 (72)	1.05 (255)	1.24 (301)		2.58 (628)

In both the 1998 and 1999 year classes, chinook salmon fingerlings stocked directly into the Kewaunee River at the intermediate distances were recovered at BAFF at higher rates than those stocked in the harbor or those stocked at the stocking site furthest upstream (Table 4, Figure 1). Cumulative recovery rate of the 1998 year class at BAFF through age 4+ Ranged from 1.32 percent for the fingerlings stocked at Clyde's Hill Road, 0.92 percent for the lot stocked at BAFF, 0.73 percent for the fingerlings released at Highway 54, to 0.46 percent for the harbor stocked individuals. Cumulative recovery rate for the 1999 year class of study fish was considerably higher through age 3+ than the 1998 year class through age 4+. Cumulative recovery rate for the 1999 year class ranged from 4.81 percent for the fingerlings stocked at Clyde's Hill Road and those stocked at BAFF, 4.12 percent for the study lot stocked in the harbor, to 2.58 percent for the fingerlings stocked furthest upstream at Highway 54.

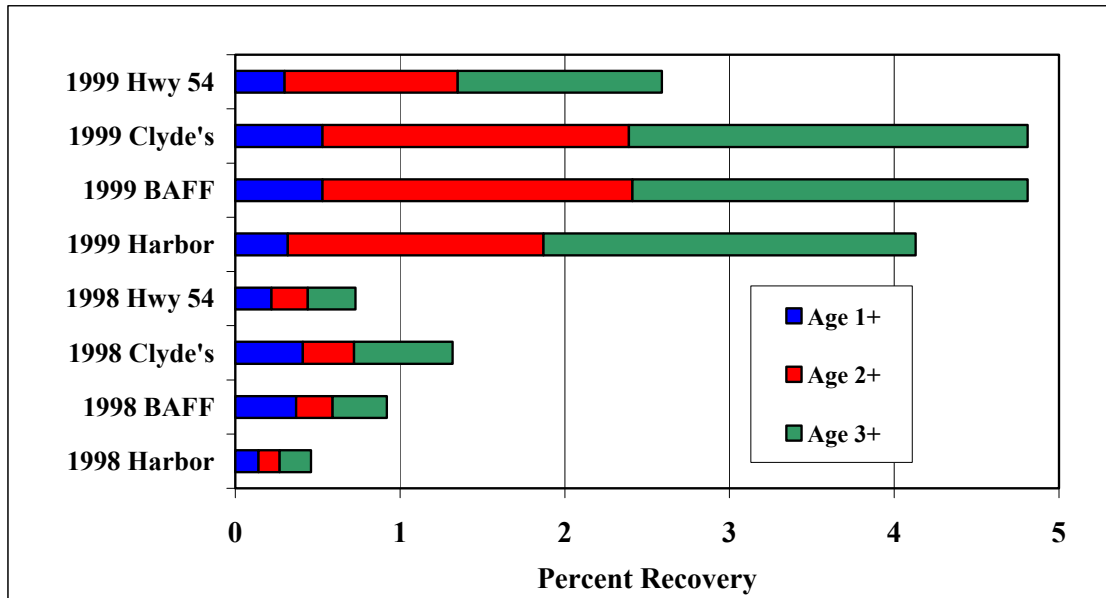


Figure 1.-Percent recovery of CWT chinook salmon, from the 1998 and 1999 year classes, at age, at the Besadny Anadromous Fisheries Facility, from the stocking technique study, through fall 2002.

These recovery rates represent a minimum known recovery rate at BAFF. Each fall during the recovery period, some of the adipose clipped chinook encountered at BAFF were not retained for CWT extraction because they were dead when processed and had started to decompose. Others were collected but the tag was lost during extraction, or it was determined that the fish was no longer carrying a CWT (tag loss before capture). Additionally, a portion of the chinook heads collected from BAFF during fall 2002 (~250) did not freeze properly during storage and had to be disposed of because of the advanced stage of decomposition. Comparison of the recovery rates between study groups within a year class should still be valid as it is unlikely that the study group to which an individual fish belonged influenced the likelihood of having a tag successfully extracted.

#### Miscellaneous Recoveries

In addition to the recovery of chinook from this study at BAFF, twelve chinook from the stocking location study were also recovered as strays at the WDNR SCW, and 188 study chinook were caught and turned in by anglers participating in the Lake Michigan sport fishery (Table 5). Compared to the 4,771 study chinook recovered at BAFF, the twelve study chinook recovered as strays at SCW is a relatively small sample size. However, ten of the twelve strays (83.3 percent) that showed up at SCW were from the harbor stocking site. This would seem to indicate that chinook stocked in the harbor are not as strongly imprinted, and are more likely to stray.

Table 5.-Number and cumulative rate of return for chinook salmon stocking technique study, from miscellaneous sources of CWT recovery. Rate of return expressed as a percent of the number of chinook stocked in the Kewaunee River that were recovered. The actual number of fish recovered is followed by the percent return in parentheses.

YEAR CLASS	STOCKING LOCATION	MISCELLANEOUS SOURCES OF CWT RECOVERY			CUMULATIVE NUMBER AND (RATE OF RETURN) MISCELLANEOUS SOURCES
		WISCONSIN SPORT ANGLERS	MICHIGAN SPORT ANGLERS	STRAYS TO STRAWBERRY CREEK WEIR	
1998	HARBOR	10 (0.04)	4 (0.02)	0	14 (0.06)
	BAFF	5 (0.02)	2 (0.01)	0	7 (0.03)
	CLYDE'S	5 (0.02)	5 (0.02)	0	10 (0.04)
	HWY 54	1 (<0.01)	9 (0.04)	0	10 (0.04)
1999	HARBOR	30 (0.14)	22 (0.10)	10	62 (0.28)
	BAFF	9 (0.04)	28 (0.11)	2	39 (0.16)
	CLYDE'S	14 (0.06)	22 (0.09)	0	36 (0.15)
	HWY 54	9 (0.04)	13 (0.05)	0	22 (0.09)

Strawberry Creek is logically not the only location to which chinook salmon from this study on the Kewaunee River would stray, but it is the only other salmon collection facility in the vicinity at which chinook were captured and checked for identifying fin clips. If in fact the percentage of chinook straying to SCW is representative of all the chinook straying from the Kewaunee River, harbor stocking would seem to be a more viable stocking alternative than indicated by returns to BAFF alone.

Study fish caught by sport anglers, affords another analysis of the study results (Table 5). Of the 188 study fish caught and turned in by anglers, 66 (35.1 percent) were harbor stocked, 44 (23.4 percent) were stocked at BAFF, 46 (24.5 percent) were stocked at Clyde's Hill Road, and 32 (17.0 percent) were stocked at US Highway 54. A sample size of 188 does not have the same robustness as a sample size of 4,771. However, if in fact, the 188 fish are representative of the chinook salmon caught by anglers, harbor stocking of chinook would seem to be a more viable alternative than indicated by the BAFF recoveries.

In the previous study of chinook stocking locations conducted by the WDNR (Peeters and Toney, 1995), the single lot of chinook stocked in the East Twin Harbor (unplanned and unreplicated) was recovered at a higher rate than all other stocking techniques.

### Size at Age

Stocking location did not impact the length and weight at age of chinook returning to and recovered at BAFF (Appendix B and C). Length and weight at age for male and female chinook, within a year class, from both the 1998 and 1999 year classes did not vary significantly by stocking location. As an example, at age 1+, the average length for all four study lots of male chinook in the stocking location study, from the 1998 year class, were within 17.1 mm. At age 2+ and age 3+ the average lengths at age, between the four study groups, were within 16.8 mm and 3.2 mm respectively. Similar small differences between the four stocking locations were noted for both sexes of both year classes.



There was a difference in size at age between the 1998 and 1999 year classes of chinook that were part of the stocking location study. Both sexes of the 1998 year class were larger in length and weight at all ages than individuals from the 1999 year class (Figure 2). CWT chinook from SCW studies from the 1998 and 1999 year classes exhibited an almost identical pattern of growth (Figure 2). The implication would be that the size at age of chinook salmon is determined by conditions in Lake Michigan proper and not by stocking location.

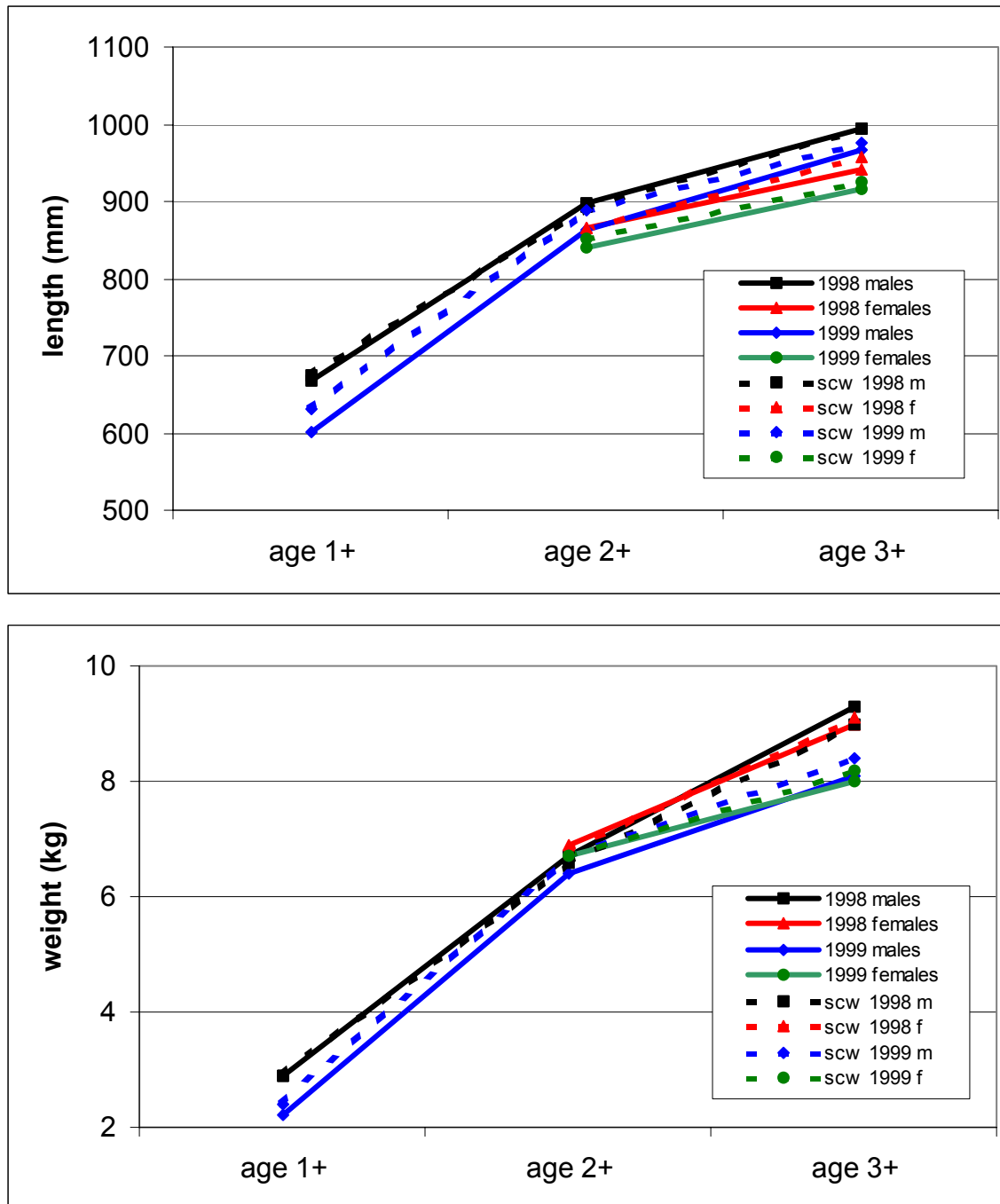


Figure 2.-Length and weight at age for known age CWT chinook from the 1998 and 1999 year classes. Fish graphed with solid lines are from the Kewaunee River stocking technique study and fish graphed with dashed lines are from SCW studies.

The primary objectives of the WDNR for stocking chinook fingerlings in Lake Michigan are to support and maintain a put, grow, and catch salmon sport fishery and to help control alewife populations. Chinook are not reproducing in Wisconsin tributaries to Lake Michigan, and to sustain the chinook population, it is necessary for WDNR to keep stocking fingerlings on an annual basis. Stocking with subsequent imprinting in rivers with salmon collection weirs is important to assure a reliable and adequate supply of mature chinook for gamete collection. The WDNR operates three salmon collection facilities on Lake Michigan. The primary chinook egg collection facility is at Strawberry Creek in Door County. In normal years, WDNR collects all of the chinook gametes needed for stocking back into Lake Michigan at this facility. The other WDNR salmon collection facilities are considered backup facilities for chinook gamete collection. This study demonstrates that stocking chinook fingerlings in the river 4-9 miles upstream from the mouth enhanced chinook recovery rates at BAFF. Stocking chinook fingerlings in the harbor or at greater distances upstream (15 miles) resulted in lower recoveries at BAFF. However, this study and the study conducted by the WDNR in the late 1980's (Peeters and Toney 1995) demonstrated that chinook fingerlings stocked in the harbor of large rivers experienced higher angler recovery rates than fingerlings stocked further upstream.

## **MANAGEMENT RECOMMENDATIONS**

On rivers where it is important to encourage a mature chinook spawning run, for the purposes of gamete collection, or to encourage an in river fall sport fishery, chinook fingerlings should be stocked directly into the river. Further, it would seem appropriate based on this present study, to stock chinook fingerlings upstream from the harbor areas but within ten miles of the mouth of the river to ensure adequate imprinting, but not excessive in river mortality.

In situations where no gamete collection is planned, chinook contribution to the sport fishery and alewife control are the primary objectives. Imprinting and stream fidelity are less important. In these stocking situations, based on past and present studies, river stocking of chinook fingerlings is strongly recommended whenever possible. However, in this situation chinook fingerlings should be stocked lower in the river, including harbor stocking where appropriate. As a result of the lower stream fidelity at maturity, this technique is also likely to encourage straying to other streams when these fish mature and commence their spawning run.

Finally, the stocking of chinook fingerlings directly into Lake Michigan or Green Bay should be discouraged as much as possible. The past stocking technique study by WDNR (Peeters and Toney 1995) demonstrated that direct lake stocking of chinook fingerlings was the least effective technique of chinook fingerling stocking.

This study was designed to use the BAFF as the primary CWT recovery technique as mature chinook salmon completed their spawning run. Although there was no consistent attempt to recover study fish lake wide, CWT chinook from this study were recovered from anglers throughout Lake Michigan. Many of the angler returns for this study came from Michigan

anglers. Likewise, Wisconsin anglers during this same time period caught numerous CWT chinook that upon CWT extraction and decoding, proved to be Michigan DNR study fish. It is apparent from this and other CWT studies, that the stocking location of chinook salmon has little to do with where in Lake Michigan these fish were caught during the open lake fishery. It is equally apparent that chinook do imprint, and have a high degree of stream fidelity at maturity.

In future chinook studies on Lake Michigan, angler recoveries should be encouraged. Angler recoveries of CWTs contributed an important and unexpected vantage point of analysis to this study. In past studies an extensive amount of effort was put into collecting CWTs from anglers with limited success. In this study, even though the effort to recover CWTs from anglers was not as extensive, the limited recoveries were important in the interpretation of the study results.

## REFERENCES

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- Peeters, P. J. and M. L. Toney. 1995. Chinook salmon stocking methods study. Wisconsin Department of Natural Resources. Unpublished report. 16 p.
- Tabor, R. A., R. S. Shively, and T. P. Poe. 1993. Predation on juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. *North American Journal of Fisheries Management* 13:831-838.

Appendix A.-Summary of CWT chinook salmon harvested at the Besadny Anadromous Fisheries Facility, fall 1999 through fall 2002. The chinook released in the Kewaunee River were part of a chinook fingerling stocking evaluation. The chinook released at all other sites were strays to the Kewaunee River.

YEAR OF CAPTURE 1999	YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
	1998	Kewaunee River (Harbor) <sup>1</sup>	1+	WIS DNR	35
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	94
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	105
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	57
		Strawberry Creek, WI		WIS DNR	47
		Various Mich sites		MICH DNR	3
	1997	Strawberry Creek, WI	2+	WIS DNR	81
	1996	Strawberry Creek, WI	3+	WIS DNR	50
	1994	Strawberry Creek, WI	5+	WIS DNR	1
YEAR OF CAPTURE 2000	YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
	1999	Kewaunee River (Harbor) <sup>1</sup>	1+	WIS DNR	70
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	129
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	129
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	72
		Strawberry Creek, WI		WIS DNR	8
		Various Mich sites		MICH DNR	3
	1998	Kewaunee River (Harbor) <sup>1</sup>	2+	WIS DNR	34
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	57
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	78
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	56
		Strawberry Creek, WI		WIS DNR	15
		Various Mich sites		MICH DNR	2
	1997	Strawberry Creek, WI	3+	WIS DNR	18
	1996	Strawberry Creek, WI	4+	WIS DNR	2

Appendix A continued.

YEAR OF CAPTURE 2001	YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
	2000	Strawberry Creek, WI	1+	WIS DNR	13
		Various Mich sites		MICH DNR	7
	1999	Kewaunee River (Harbor) <sup>1</sup>	2+	WIS DNR	341
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	460
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	457
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	255
		Strawberry Creek, WI		WIS DNR	63
		Various Mich sites		MICH DNR	1
	1998	Kewaunee River (Harbor) <sup>1</sup>	3+	WIS DNR	48
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	85
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	153
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	75
		Strawberry Creek, WI		WIS DNR	7
YEAR OF CAPTURE 2002	YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
	2001	Strawberry Creek, WI <sup>1</sup>	1+	WIS DNR	10
		Various Mich sites		MICH DNR	5
	2000	Strawberry Creek, WI	2+	WIS DNR	30
		Various Mich sites		MICH DNR	5
	1999	Kewaunee River (Harbor) <sup>1</sup>	3+	WIS DNR	498
		Kewaunee River (BAFF) <sup>2</sup>		WIS DNR	587
		Kewaunee River (Clyde's) <sup>3</sup>		WIS DNR	594
		Kewaunee River (Hwy. 54) <sup>4</sup>		WIS DNR	301
		Strawberry Creek, WI		WIS DNR	33
		Various Mich sites		MICH DNR	2
	1998	Kewaunee River (Clyde's) <sup>3</sup>	4+	WIS DNR	1

<sup>1</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.

<sup>2</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.

<sup>3</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.

<sup>4</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.

Appendix B.-Average length (mm) by age, sex, and year of return of CWT chinook salmon stocked as part of the stocking technique study in the Kewaunee River and recaptured at the BAFF on the Kewaunee River, Kewaunee County, 1999 through 2002.

YEAR OF RETURN	SEX		AGE				
			1+	2+	3+	4+	5+
1999 <sup>1</sup>	M	L (sd) range n	660.8(35.9) 562-730 35	- - -	- - -	- - -	- - -
	F	L (sd) range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>2</sup>	M	L (sd) range n	664.1(31.9) 595-740 94	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>3</sup>	M	L (sd) range n	668.3(36.4) 520-782 105	- - -	- - -	- - -	- - -
	F	L (sd) range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>4</sup>	M	L (sd) range n	677.9(31.6) 604-743 57	- - -	- - -	- - -	- - -
	F	L (sd) range n	- - -	- - -	- - -	- - -	- - -
2000 <sup>1</sup>	M	L (sd) range n	587.6(38.4) 512-668 70	901.9(39.1) 847-1,010 26	- - -	- - -	- - -
	F	L (sd) range n	- - -	877.6(28.0) 840-912 8	- - -	- - -	- - -
2000 <sup>2</sup>	M	L (sd) range n	604.6(36.7) 492-680 129	885.2(53.5) 723-966 44	- - -	- - -	- - -
	F	L (sd) range n	- - -	855.9(28.1) 817-903 13	- - -	- - -	- - -
2000 <sup>3</sup>	M	L (sd) range n	608.7(40.2) 493-707 129	900.0(38.2) 819-1,000 56	- - -	- - -	- - -
	F	L (sd) range n	- - -	873.2(31.2) 804-952 22	- - -	- - -	- - -
2000 <sup>4</sup>	M	L (sd) range n	603.4(31.2) 522-664 72	902.0(39.7) 772-983 46	- - -	- - -	- - -
	F	L (sd) range n	- - -	855.3(34.7) 795-900 10	- - -	- - -	- - -

Appendix B.-Continued.

2001 <sup>1</sup>	M	L (sd) range n	- - -	860.1 (55.1) 686-999 307	995.2 (61.6) 812-1,103 23	- - -	- - -
	F	L (sd) range n	- - -	837.2 (49.6) 761-986 34	941.9 (49.4) 801-1,026 25	- - -	- - -
2001 <sup>2</sup>	M	L (sd) range n	- - -	865.2 (52.8) 671-1,005 389	996.4 (56.2) 873-1,070 27	- - -	- - -
	F	L (sd) range n	- - -	844.8 (41.1) 760-941 71	939.0 (52.9) 740-1,034 58	- - -	- - -
2001 <sup>3</sup>	M	L (sd) range n	- - -	863.5 (50.6) 680-993 400	993.2 (67.6) 700-1,102 67	- - -	- - -
	F	L (sd) range n	- - -	843.1 (45.1) 703-934 57	943.2 (48.4) 805-1,062 86	- - -	- - -
2001 <sup>4</sup>	M	L (sd) range n	- - -	863.1 (54.8) 695-1,045 220	995.2 (56.9) 810-1,125 32	- - -	- - -
	F	L (sd) range n	- - -	834.7 (36.5) 758-924 35	942.8 (50.8) 792-1,033 43	- - -	- - -
2002 <sup>1</sup>	M	L (sd) range n	- - -	- - -	966.2 (69.0) 601-1,124 238	- - -	- - -
	F	L (sd) range n	- - -	- - -	920.0 (47.6) 620-1,086 260	- - -	- - -
2002 <sup>2</sup>	M	L (sd) range n	- - -	- - -	964.1 (65.9) 715-1,100 238	- - -	- - -
	F	L (sd) range n	- - -	- - -	914.0 (50.8) 665-1,068 349	- - -	- - -
2002 <sup>3</sup>	M	L (sd) range n	- - -	- - -	968.3 (62.0) 717-1,127 211	920.0 920.0 1	- - -
	F	L (sd) range n	- - -	- - -	916.0 (53.3) 582-1,052 383	- - -	- - -
2002 <sup>4</sup>	M	L (sd) range n	- - -	- - -	971.2 (53.7) 807-1,072 104	- - -	- - -
	F	L (sd) range n	- - -	- - -	912.7 (52.9) 701-1,036 197	- - -	- - -



Appendix B.-Continued.

<sup>1</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.

<sup>2</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.

<sup>3</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.

<sup>4</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.

Appendix C.-Average weight (kg) by age, sex, and year of return of CWT chinook salmon stocked as part of the stocking technique study in the Kewaunee River and recaptured at the BAFF on the Kewaunee River, Kewaunee County, 1999 through 2002.

YEAR OF RETURN	SEX		AGE				
			1+	2+	3+	4+	5+
1999 <sup>1</sup>	M	W (sd) range n	2.9 (0.5) 1.7-3.7 33	- - -	- - -	- - -	- - -
	F	W (sd) range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>2</sup>	M	W (sd) range n	2.8 (0.5) 1.6-4.1 86	- - -	- - -	- - -	- - -
	F	W (sd) range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>3</sup>	M	W (sd) range n	2.9 (0.5) 1.3-4.4 99	- - -	- - -	- - -	- - -
	F	W (sd) range n	- - -	- - -	- - -	- - -	- - -
1999 <sup>4</sup>	M	W (sd) range n	3.0 (0.5) 2.0-4.1 53	- - -	- - -	- - -	- - -
	F	W (sd) range n	- - -	- - -	- - -	- - -	- - -
2000 <sup>1</sup>	M	W (sd) range n	2.0 (0.5) 1.2-3.6 68	6.7 (0.9) 5.2-8.4 26	- - -	- - -	- - -
	F	W (sd) range n	- - -	7.4 (1.0) 6.1-8.7 8	- - -	- - -	- - -
2000 <sup>2</sup>	M	W (sd) range n	2.1 (0.4) 1.0-3.1 128	6.5 (1.2) 3.4-8.4 42	- - -	- - -	- - -
	F	W (sd) range n	- - -	6.7 (0.9) 5.5-8.5 13	- - -	- - -	- - -
2000 <sup>3</sup>	M	W (sd) range n	2.3 (0.5) 1.1-3.6 129	6.8 (1.0) 5.0-9.5 54	- - -	- - -	- - -
	F	W (sd) range n	- - -	7.1 (0.7) 5.8-8.9 22	- - -	- - -	- - -
2000 <sup>4</sup>	M	W (sd) range n	2.2 (0.4) 1.5-3.2 71	6.7 (1.0) 3.7-8.5 46	- - -	- - -	- - -
	F	W (sd) range n	- - -	6.3 (0.8) 4.4-7.3 10	- - -	- - -	- - -

Appendix C.-Continued

2001 <sup>1</sup>	M	W (sd) range n	- - -	6.2 (1.3) 2.5-10.1 307	9.1 (1.8) 5.1-12.1 23	- - -	
	F	W (sd) range n	- - -	6.6 (1.4) 5.1-12.3 34	8.8 (1.6) 5.1-12.2 25	- - -	
2001 <sup>2</sup>	M	W (sd) range n	- - -	6.4 (1.2) 2.7-9.7 389	9.4 (1.6) 5.9-11.7 27	- - -	
	F	W (sd) range n	- - -	6.8 (1.1) 4.5-9.8 71	9.1 (1.4) 4.4-12.1 58	- - -	
2001 <sup>3</sup>	M	W (sd) range n	- - -	6.4 (1.2) 3.2-10.1 400	9.2 (1.9) 3.3-12.8 67	- - -	
	F	W (sd) range n	- - -	6.8 (1.1) 4.2-9.8 57	9.1 (1.6) 5.7-12.3 86	- - -	
2001 <sup>4</sup>	M	W (sd) range n	- - -	6.4 (1.3) 3.4-10.4 220	9.3 (1.8) 4.9-13.6 32	- - -	
	F	W (sd) range n	- - -	6.5 (0.9) 4.9-8.4 35	9.1 (1.7) 5.1-12.1 43	- - -	
2002 <sup>1</sup>	M	W (sd) range n	- - -	- - -	8.2 (1.7) 2.2-12.5 232	- - -	- - -
	F	W (sd) range n	- - -	- - -	8.1 (1.3) 2.6-11.1 253	- - -	- - -
2002 <sup>2</sup>	M	W (sd) range n	- - -	- - -	8.1 (1.6) 3.7-12.8 229	- - -	- - -
	F	W (sd) range n	- - -	- - -	8.0 (1.4) 2.9-12.5 329	- - -	- - -
2002 <sup>3</sup>	M	W (sd) range n	- - -	- - -	8.1 (1.6) 3.4-12.8 205	7.1 7.1 1	- - -
	F	W (sd) range n	- - -	- - -	7.9 (1.4) 2.4-13.2 356	- - -	- - -
2002 <sup>4</sup>	M	W (sd) range n	- - -	- - -	8.2 (1.3) 4.7-11.5 101	- - -	- - -
	F	W (sd) range n	- - -	- - -	7.9 (1.4) 4.0-11.2 191	- - -	- - -

Appendix C.-Continued.

<sup>1</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.

<sup>2</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.

<sup>3</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.

<sup>4</sup> Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.